

California Environmental Protection Agency
Air Resources Board

**Review of Current Ambient Air Monitoring Activities
Related to California Bay Area and South Coast Refineries**



Release Date: March, 2002

**State of California
California Environmental Protection Agency**

**AIR RESOURCES BOARD
Monitoring Laboratory Division**

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<http://www.arb.ca.gov/aaqm/qmosqual/qmosqual.htm>

Review of Current Ambient Air Monitoring Activities Related to California Bay Area and South Coast Refineries

A. Introduction

Recently, the California Air Resources Board (CARB) announced its interest in learning more about exposure to air pollutants at the local or community level; specifically for individuals living near sources of air pollutants. In particular, staff were directed to establish an inventory of the air monitoring activities in close proximity to oil refineries in order to understand whether pollutant contributions from refineries unduly impact nearby communities. The information included in this report addresses only the monitors operated by State or local Air Districts, or those they require. Other discretionary monitors operated by refineries and/or community groups were not surveyed as part of this project.

B. Current California Air Monitoring Network

Ambient air is defined rather simply as outdoor air the public may access. This includes air present throughout a vast range including agricultural areas, mountains, coastal plateaus, deserts, and cities. Monitoring air quality is an essential element to help guide efforts in attaining clean air in California. The responsibility of developing networks, maintaining instruments, assessing data quality, and updating monitors (as needed) are shared by state and local entities.

Air monitoring is undertaken in California at approximately 280 air quality monitoring stations located throughout the state. Monitoring for ambient air pollutants occurs in urban and rural environments, some of which have significant oil refining activity. The CARB shares monitoring responsibilities with local Air Pollution Control and Air Quality Management Districts, the National Parks Service, and private contractors. Air quality data collected at these stations are used by state, local, and federal agencies to assess the effectiveness of control measures, identify emissions trends, support the agricultural burn program, aid air modeling and emissions inventory, and determine if an area meets California or federal health-based ambient air quality standards.

The ambient air monitoring network in California consists of equipment capable of measuring and/or collecting up to 75 ambient level compounds. The air monitoring programs that make up this sophisticated network includes gaseous pollutants, particular matter, toxic air contaminants, non-methane organic compounds, pesticides, meteorological parameters, and visibility.

California's long term air monitoring network, as referred to in this document, is comprised of three federal programs: State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring

Stations (PAMS). They operate pursuant to Title 40 Part 58 of the Code of Federal Regulations (CFR). NAMS stations are selected from the overall SLAMS network with emphasis on urban and multi-source areas and are either in areas of expected maximum concentration or in areas that combine poor air quality with a high population density. PAMS monitors constitute the smallest portion of the SLAMS network and measure ambient levels of ozone precursors as well as meteorological data. In addition to the federal air monitoring programs, the CARB, the Bay Area Air Quality Management District (BAAQMD), and the South Coast Air Quality Management District (SCAQMD) operate Special Purpose Monitoring Stations (SPMS) in support of special air quality studies. These are generally short-term, highly focussed studies designed to answer a particular question. Data collected from most monitoring are submitted to databases maintained by State (CARB) and Federal (U.S. Environmental Protection Agency) agencies.

Network design is aided by an understanding of the nature of pollutant behavior and distribution, and is done with a focus on assessing and tracking air levels that represent a community at large. An air monitoring network can include sub elements such as source-oriented monitoring, which involves monitoring near a dominant source. Other objectives might include monitoring air quality that represents a meteorological phenomenon related to pollutant transport, or to define daily or seasonal pollutant changes or patterns. To a large degree, the cost of monitoring plays a large role in determining the eventual extent of an air monitoring network. Ambient air monitoring combines all these factors in a way that the overall network represents air quality that affects a significant percentage of the public. The CARB's current network is based on a mix of neighborhood and urban scale stations. However, the network is limited when trying to better understand how (and if) a single large emissions source may affect a neighborhood or community within a city.

With the passage of the Children's Environmental Health Protection Program (Senate Bill 25, Escutia 1999) the Legislature directed CARB to investigate whether the long standing ambient air monitoring network in California adequately considers children's exposure to pollutants in establishing air quality standards. Under the program, the CARB is required to establish monitors at locations frequented by children that are specifically downwind of major emissions sources. Beginning in 2001, monitoring has been expanded beyond the current ambient air network to locations near schools, day-care centers, and recreational facilities that may be impacted by sources such as industrial facilities or high traffic areas. The following six stations were selected to make up the Children's Environmental Health Protection monitoring program network: Crockett, Fruitvale (Oakland), Fresno, Boyle Heights (Los Angeles), Wilmington (Long Beach area), and Barrio Logan (San Diego).

This inventory of air monitoring activities focuses on two regions with large oil refining capacities: the San Francisco Bay Area and the South Coast Air Basin. Large scale oil refineries are defined as having the capacity of refining 65,000 barrels of crude oil per day or more. The air monitoring stations in these areas are presented in Attachments

A-1 through A-3. The monitors included in A-1 and A-3 are designated as SLAMS, NAMS, PAMS, and SPMS and are located in communities closest to the refineries. The monitors shown in A-2 are required by the BAAQMD and record in greater detail, the air quality at a specific refinery (monitors are operated by refinery personnel). Attachment A-4 lists the stations conducting toxics monitoring and details the specific toxic pollutants that are analyzed. A list of dioxins, furans, and PCBs monitored by the BAAQMD and CARB as part of the California Ambient Dioxin Air Monitoring Program, is presented as A-5. All of the attachments can be found in the Attachment A section.

Meteorological equipment, established at or near each oil refinery, provides information important in determining the direction emissions travel from the refinery. Wind roses, generated using meteorological data (wind speed and wind direction) obtained at or near each oil refinery, are presented as Attachments B-1 through B-7, and depict the relative distribution of wind speed and wind direction for the specified areas. Maps indicating the location of each air monitoring station, with respect to the location of each oil refinery, are presented as B-8 through B-13. Ground level monitoring stations (GLMs) in the San Francisco Bay Area maps can be referenced in A-2.

Continuous emissions monitors (CEMs) are established at refineries to monitor emissions from specific sources. Monitors are typically located at boilers, cokers, furnaces, fuel gas tanks, cogenerators, and flares to monitor air pollutants such as sulfur dioxide, hydrogen sulfide, carbon monoxide, oxides of nitrogen, oxygen and carbon dioxide. CEMs are a necessary and important part of any community monitoring strategy at refineries given their ability to detect routine, non-routine, and accidental releases that might otherwise pass above and/or around the fence line and ambient monitoring station. This inventory includes only ambient air monitors.

Information presented in this document contains the most up-to-date information available and reflects comments and suggestions received from the BAAQMD. The CARB did not receive comments from the SCAQMD or the refineries (Western States Petroleum Association).

1. San Francisco Bay Area Monitoring Activities

There are ten ambient air monitoring stations located in the San Francisco Bay Area near major oil refineries. Nine of the ambient air monitoring stations featured on the maps, are designated as SLAMS and NAMS, and operate pursuant to federal regulations. In addition to the criteria pollutants, monitoring for non-criteria pollutants such as hydrocarbons, toxics, dioxins, and ions is also conducted (see A-1). The Children's Environmental Health Protection monitoring station located in Crockett, is designated a Special Purpose Monitoring station that was intentionally sited to monitor potential impacts of the major oil refineries and storage facilities located in Martinez, Rodeo, Benicia, and Hercules.

Ground level monitors (GLMs), shown in A-2, are special purpose monitoring stations that operate near refineries. The BAAQMD regulations require facilities that emit specific types of pollutants to perform monitoring in order to demonstrate compliance on a continuous basis. GLMs typically record concentrations of hydrogen sulfide (H₂S) and/or sulfur dioxide (SO₂) at facility boundaries.

2. South Coast Air Monitoring Activities

The South Coast Air Basin is the largest metropolitan region in the state and has a heavy concentration of oil refining operations. There are four ambient air monitoring stations in the South Coast located near oil refineries. The Children's Environmental Health Protection monitoring program station in Wilmington was sited to monitor the potential impacts of the refineries in that area and is designated a Special Purpose Monitoring station. The remaining three stations overlap in SLAMS, NAMS, and PAMS designations for the criteria pollutants monitored. The SCAQMD laboratory performs the analyses for all pollutants except toxics. The North Long Beach station is set up for toxics sampling for which the CARB laboratory performs the analyses.

C. Quality Assurance

1. CARB

The Monitoring and Laboratory Division's (MLD) Quality Assurance Section (QAS) supports regulatory ambient air monitoring programs undertaken by the MLD and local districts. It is the goal of the MLD to provide accurate, relevant, and timely measurements of air pollutants. The QAS conducts various quality assurance activities to ensure that data collected comply with procedures and regulations set forth by the U.S. Environmental Protection Agency and can be considered good quality data and data-for-record.

The objective of quality assurance is to provide accurate and precise data, minimize data loss due to malfunctions and to assess the validity of the air monitoring data in order to provide representative and comparable data of known precision and accuracy. This is accomplished by conducting regular performance audits, on-site system audits, interlaboratory comparisons, and periodic evaluations of internal quality control data.

2. San Francisco Bay Area

The BAAQMD's quality assurance group supports both its ambient and GLM programs. The goal is to verify the accuracy of the data being generated and assure that it complies with procedures and regulations set forth by the U.S. EPA, CARB, and

BAAQMD. The CARB's QAS provides additional verification that the ambient data generated are good quality by conducting annual spot-check performance audits.

The quality assurance group's objective for the ambient air monitoring program is to verify the accuracy of the data collected to be used in various programs to protect public health. This is accomplished by following approved procedures and protocols, conducting audits, and following good quality control and laboratory practices.

The quality assurance group's objective for GLM auditing is to verify that the data provided is accurate and can be used for determining the nature and quantity of sulfur dioxide and hydrogen sulfide emissions. The GLM facilities, as well as the instrumentation, must be properly sited, operated, and maintained. The refineries are responsible for these stations which are typically maintained by contractors.

3. South Coast

The SCAQMD criteria pollutant data are evaluated against federal regulations for precision, accuracy, and completeness. The SCAQMD's monitoring objectives are to provide accurate and precise data that meet the monitoring requirements, minimize data loss, and to assess air monitoring data quality to provide data that meet the data quality objectives for accuracy, precision, and completeness.

The SCAQMD accomplishes their objectives by following established procedures and protocols, conducting good quality control and laboratory practices, maintaining appropriate documentation, and conducting regular performance audits. The CARB's QAS provides additional verification that the ambient data generated are good quality by conducting annual spot-check performance audits.

D. Data Reporting and Availability

Obtaining ambient air monitoring data real-time is ideal when investigating routine, non-routine, and upset conditions that may occur at a refinery. Real-time data can be useful during routine and non-routine releases as an indication of whether unusual levels of pollutants are being detected, to support public notification of incidents, and to determine the dispersal pattern of the emissions.

Refinery personnel may also use the data for other emergency response activities such as to trigger sampling of specific pollutants, trigger a pump to shutdown, set alert levels, or to create a historical database to track trends of refinery emissions. Community members and public agency members may also use the data to evaluate changes in the concentrations of specific pollutants in efforts to determine any adverse health effects on a day to day (chronic) exposure as well as short term (acute, upset conditions).

1. CARB

The CARB currently provides real-time data access for the SB25 air monitoring stations as part of the Children's Environmental Health Protection program. Data are available for O₃, NO, NO_x, NO₂, SO₂, NMHC, CO, and MET. Data can be viewed at: <http://www.arb.ca.gov/aaqm/qmospas/chm/cehp/sites/sites.htm> by accessing the data query link for the Wilmington air monitoring station. The Crockett data will be available in the near future. It should be noted that these data have not been validated and are subject to change.

2. Bay Area

The data generated for both the ambient air monitoring network and the GLM network are primarily used by the BAAQMD. The majority of the stations are equipped with telemetry systems. District staff are in the process of creating a web page to allow real-time data access (no time frame was given as to when real time data access will be available).

In addition, the BAAQMD utilizes real-time data to calculate Air Quality Index (AQI) readings. The AQI readings are available by region on a real-time basis for O₃, NO₂, SO₂, CO, and PM pollutants. The BAAQMD also uses the data to create maps of the region that show ozone levels over time. These data can be accessed via the BAAQMD's web page at www.sparetheair.org/. The data used to calculate the AQI readings and create the ozone maps have not been validated and are subject to change. Data are also available upon request by contacting the District or accessing the U.S. EPA's Aerometric Information Retrieval System (AIRS), however, these data are generally not available real-time.

3. South Coast

The South Coast AQMD also collects monitoring data in real-time. These data are routinely processed to calculate AQI readings. The AQI readings are available by region on a real-time basis for O₃, NO₂, CO, and PM pollutants. These data can be accessed via the District's web page at: www.aqmd.gov/smog/. The data used to calculate the AQI readings have not been validated and are subject to change. Data are also available upon request by contacting the District or by accessing the U.S. EPA's AIRS database, however, these data are generally not available real-time.

ATTACHMENT A

*Review of Current Ambient Air Monitoring Activities
Related to California Bay Area and South Coast Refineries*

**Attachment A-1:
Air Monitoring Stations in the San Francisco Bay Area
Near Refineries Operated by BAAQMD or CARB***

	Pollutants Monitored																	
	Continuous Analyzers										Integrated Field Sample							
Station Name	Sulfur Dioxide (SO2)	Hydrogen Sulfide (H2S)	Carbon Monoxide (CO)	Nitrogen Dioxide (NO2)	Ozone (O3)	Total Hydrocarbons (HC)	Methane (CH4)	Total Non-Methane Hydrocarbons (NMHC)	PM2.5 (BAM)	Aethelometer (Black Carbon)	TSP (Ions)	PM10 (Particulates)	PM10 (Ions)	PM10 (Elemental Carbon)	PM10 (PAH)	PM 2.5 (Mass)	Toxic Gases and/or Metals	Dioxins, Furans, and PCBs
Special Purpose Monitoring (CARB)																		
Crockett-Pomona (SB 25) ¹	X	X ²	X	X	X			X	X	X	X ³	X	X	X	X		X	X
NAMS and SLAMS Designations (Bay Area AQMD)																		
**Concord-Arnold Way																	X	
Concord-Treat Blvd	X ⁶		X ⁴	X ⁴	X ⁴	X ⁷	X ⁷				X ⁷	X ⁶				X ⁶	X	
Crockett-Kendall	X ⁶																X	
Martinez-Jones St	X ⁶																	
Pittsburg-10 th St.	X ⁴		X ⁶	X ⁶	X ⁶							X ⁷					X	
Point Richmond ⁸		X																
Richmond-7 th St.	X ⁶	X															X	X
Rodeo-3 rd St.		X																
San Pablo-El Portal	X ⁶		X ⁶	X ⁶	X ⁶												X	
Vallejo-Tuolemn St.	X ⁶		X ⁶	X ⁶	X ⁶	X ⁷	X ⁷				X	X ⁶				X ⁶	X	

X= Pollutant monitored.

¹ Six SB 25 stations make up the Children's Environmental Health Protection Monitoring Program network, they include Crockett (Pomona Ave.), Fruitvale (Oakland), Fresno, Boyle Heights (Los Angeles), Wilmington (Long Beach area), and Barrio Logan (San Diego).

² Monitoring for H₂S is planned for Crockett and Wilmington.

³ Ions are measured off of the Anderson Hi Vol.

⁴ NAMS designation

⁵ PAMS designation

⁶ SLAMS designation

⁷ Unknown/Other designation

⁸ Special Purpose Monitoring Station operated by BAAQMD, no record of data in federal database since 1982.

* Designations obtained from QA audit information, CARB State and Local Air Monitoring Network Plan handbook, and a BAAQMD Air Monitoring Network list obtained from BAAQMD staff.

** Station has not been identified in either of the federal or state databases.

**Review of Current Ambient Air Monitoring Activities
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Attachment A-2:

**Ground Level Monitors in the San Francisco Bay Area Operated by
Refinery and or BAAQMD and required by BAAQMD***

	Pollutants Analyzed	
	Continuous Analyzers	
Station Names	Hydrogen Sulfide (H ₂ S)	Sulfur Dioxide (SO ₂)
Chevron (Richmond)		
1) Castro St.	X	X
2) Golden Gate	X	X
3) Gertrude	X	X
Tesoro (Martinez)		
1) Chenery	X	X
2) Gun Club	X	X
3) Pacheco Slough	X	
4) Waterfront Road	X	X
Shell (Martinez)		
1) Ace Hardware	X	X
2) Effluent Treatment	X	
3) Mountain View	X	
4) Shell Avenue	X	
Valero (Benicia)		
1) Gas Station	X	X
2) Water Treatment	X	X
3) Warehouse	X	X
Phillips (Rodeo)		
1) Crockett	X	X
2) East Refinery	X	X
3) Hillcrest School	X	X

X= Pollutant monitored.

*Information obtained from the BAAQMD's Enforcement Division

See Attachments B-8 through B-12 for maps of the GLMs.

*Review of Current Ambient Air Monitoring Activities
Related to California Bay Area and South Coast Refineries*

Attachment A-3:

**Air Monitoring Stations in the South Coast Area
Near Refineries Operated by the SCAQMD or CARB***

	Pollutants Monitored																	
	Continuous Analyzers										Integrated Field Sample							
Station Name	Sulfur Dioxide (SO ₂)	Hydrogen Sulfide (H ₂ S)	Carbon Monoxide (CO)	Nitrogen Dioxide (NO ₂)	Ozone (O ₃)	Total Hydrocarbons (HC)	Methane (CH ₄)	Total Non-Methane Hydrocarbons (NMHC)	PM2.5 (BAM)	Aethelometer (Black Carbon)	TSP (Ions)	PM10 (Particulates)	PM10 (Ions)	PM10 (Elemental Carbon)	PM10 (PAH)	PM 2.5 (Mass)	Toxic Gases and/or Metals	Dioxins, Furans, and PCBs
Special Purpose Monitoring (CARB)																		
Wilmington (SB 25) ¹	X	X ²	X	X	X			X	X	X	X ³	X	X	X	X		X	X
NAMS, SLAMS, and PAMS Designations (South Coast AQMD)																		
Hawthorne	X ⁴		X ⁶	X ^{5,6}	X ^{5,6}	X ⁷		X			X ⁷	X ⁶						
Lynwood	X ⁶		X ⁴	X ⁶	X ⁶		X ⁷		X ⁶		X ⁷					X ⁶		
North Long Beach	X ⁴		X ⁶	X ⁶	X ⁶	X ⁷	X ⁷	X			X ⁷	X ⁴				X ⁶	X	

X= Pollutant monitored.

¹ Six SB 25 stations make up the Children's Environmental Health Protection Monitoring Program network, they include Crockett (Pomona Ave.), Fruitvale (Oakland), Fresno, Boyle Heights (Los Angeles), Wilmington (Long Beach area), and Barrio Logan (San Diego).

² Monitoring for H₂S is planned for Crockett and Wilmington.

³ Ions are measured off of the Anderson Hi Vol.

⁴ NAMS designation

⁵ PAMS designation

⁶ SLAMS designation

⁷ Unknown/Other designation

* Designations obtained from QA audit information and from the CARB State and Local Air Monitoring Network Plan handbook.

Attachment A-4: Toxic Pollutants Monitored

Station Names	Benzo(b)fluorantene	Benzo(k)fluorantene	Benzo(a)pyrene	Dibenz(a,h)anthracene	Benzo(g,h,i)perylene	Indeno(1,2,3-c,d)pyrene	Formaldehyde	Acetaldehyde	Methyl Ethyl Ketone	Benzene	Toluene	Ethyl Benzene	<i>o</i> -, <i>m</i> / <i>p</i> -Xylene	Styrene	<i>o</i> -, <i>p</i> -Dichlorobenzene	1,3-Butadiene	Methyl Tertiary-Butyl Ether	Perchloroethylene	Trichloroethylene	Trichloroethane	Carbon Tetrachloride	Chloroform	Dichloromethane	Bromomethane	Ethylene Dichloride	Ethylene Dibromide	<i>cis</i> -1,3-Dichloropropene	<i>trans</i> -1,3-Dichloropropene	Vinyl Chloride	Chromium VI and Total Metals ¹	
San Francisco Bay Area Monitoring Stations																															
Concord Arnold										X	X					X	X	X	X	X	X	X	X		X	X			X		
Concord-Treat										X	X					X	X	X	X	X	X	X	X		X	X			X		
Crockett Kendall										X	X					X	X	X	X	X	X	X	X		X	X			X		
Crockett SB 25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	
Pittsburg 10 th										X	X					X	X	X	X	X	X	X	X		X	X			X		
Richmond 7 th										X	X					X	X	X	X	X	X	X	X		X	X			X		
San Pablo-El Portal										X	X					X	X	X	X	X	X	X	X		X	X			X		
Vallejo										X	X					X	X	X	X	X	X	X	X		X	X			X		
South Coast Area Monitoring Stations																															
Wilmington SB 25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	
N. Long Beach	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	

¹ Aluminum, Silicon, Phosphorus, Sulfur, Chlorine, Potassium, Calcium, Titanium, Vanadium, Chromium, Manganese, Iron, Cobalt, Nickel, Copper, Zinc, Arsenic, Selenium, Bromine, Rubidium, Strontium, Yttrium, Zirconium, Molybdenum, Tin, Antimony, Barium, Mercury, Lead, Uranium.

Attachment A-5:

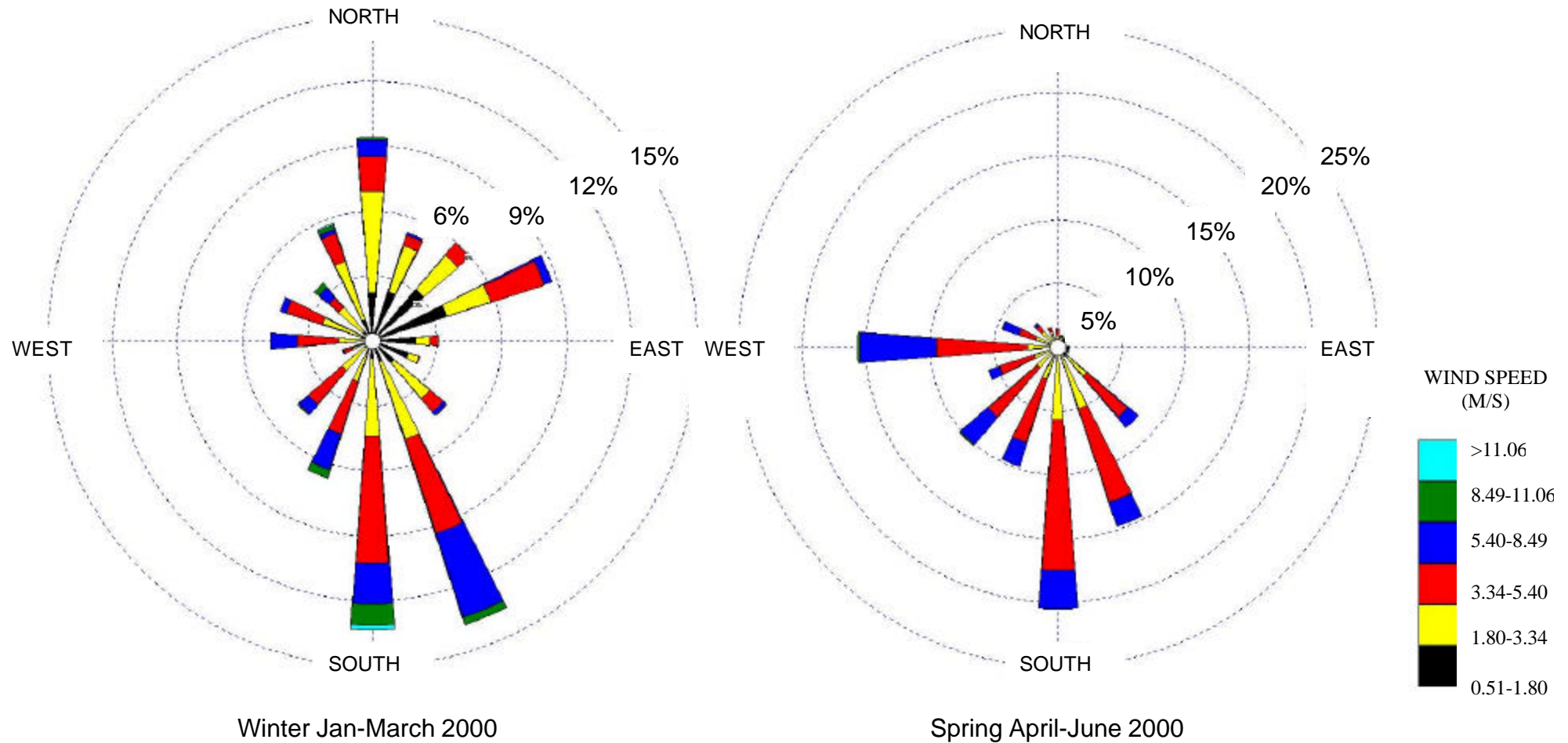
Dioxins, Furans, and PCBs Pollutants Monitored by BAAQMD and CARB

PCDDs	PCDFs
2378-Tetra CDD (TCDD) 12378-Penta CDD (PeCDD) 123478-Hexa CDD (HxCDD) 123678- HxCDD 123789- HxCDD 1234678-Hepta CDD (HpCDD) 12346789-Octa CDD (OCDD)	2378-Tetra CDF (TCDF) 12378-Penta CDF (PeCDF) 23478-PeCDF 123478-Hexa CDF (HxCDF) 123678-HxCDF 123789-HxCDF 234678-HxCDF 1234678-Hepta CDF (HpCDF) 1234789-HpCDF 12346789-Octa CDF (OCDF)
Total TCDD Total PeCDD Total HxCDD Total HpCDD Total Polychlorinated CDD (PCDD)	Total TCDF Total PeCDF Total HxCDF Total HpCDF Total PCDF
PCBs	
3,3',4,4'-TeCB (PCB 77) 3,4,4',5-TeCB (PCB 81) 2,3,3',4,4'-PeCB (PCB 105) 2,3,4,4',5-PeCB (PCB 114) 2,3',4,4',5-PeCB (PCB 118) 2',3,4,4',5-PeCB (PCB 123) 3,3',4,4',5-PeCB (PCB 126) 2,3,3',4,4',5-HxCB (PCB 156) 2,3,3',4,4',5'-HxCB (PCB 157) 2,3',4,4',5,5'-HxCB (PCB 167) 3,3',4,4',5,5'-HxCB (PCB 169) 2,2',3,3',4,4',5-HpCB (PCB 170) 2,2',3,4,4',5,5'-HpCB (PCB 180) 2,3,3',4,4',5,5'-HpCB (PCB 189)	

Note: The International Union of Pure and Applied Chemistry (IUPAC) name is in parentheses.

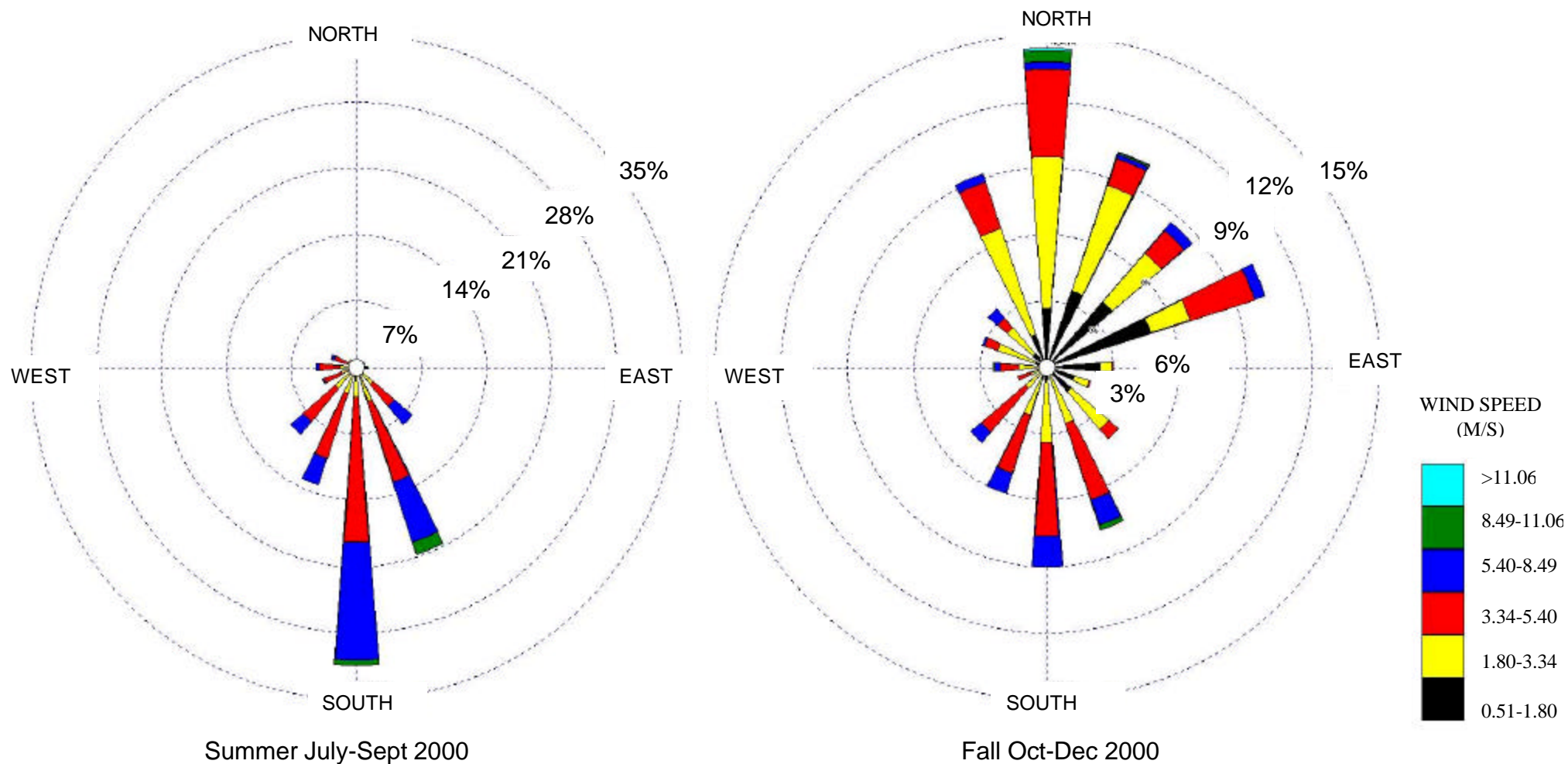
ATTACHMENT B

Attachment B-1: Seasonal Wind Roses at Chevron (Richmond) Oil Refinery



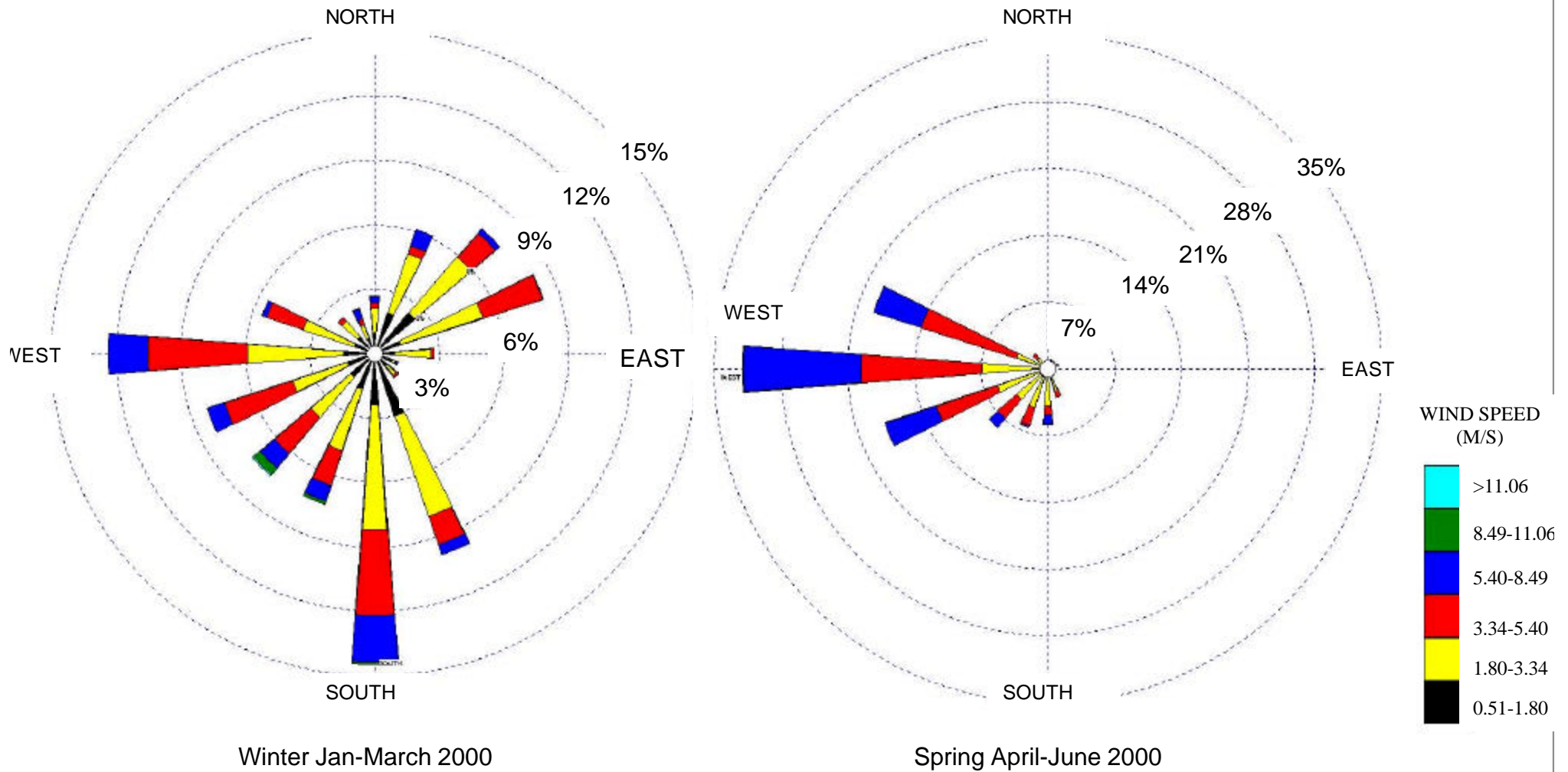
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-1: Seasonal Wind Roses at Chevron (Richmond) Oil Refinery (cont.)



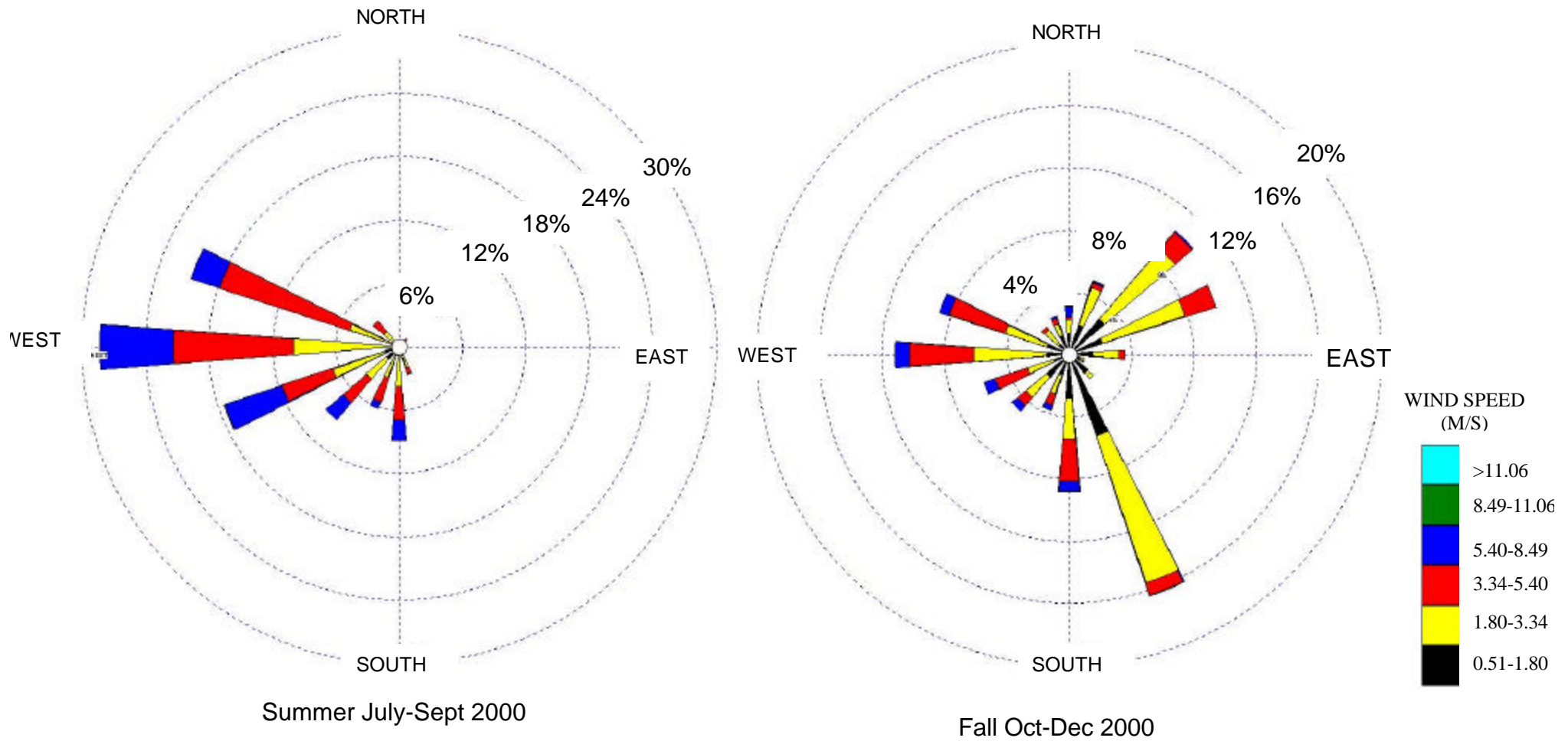
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-2: Seasonal Wind Roses at Tesoro (Martinez) Oil Refinery



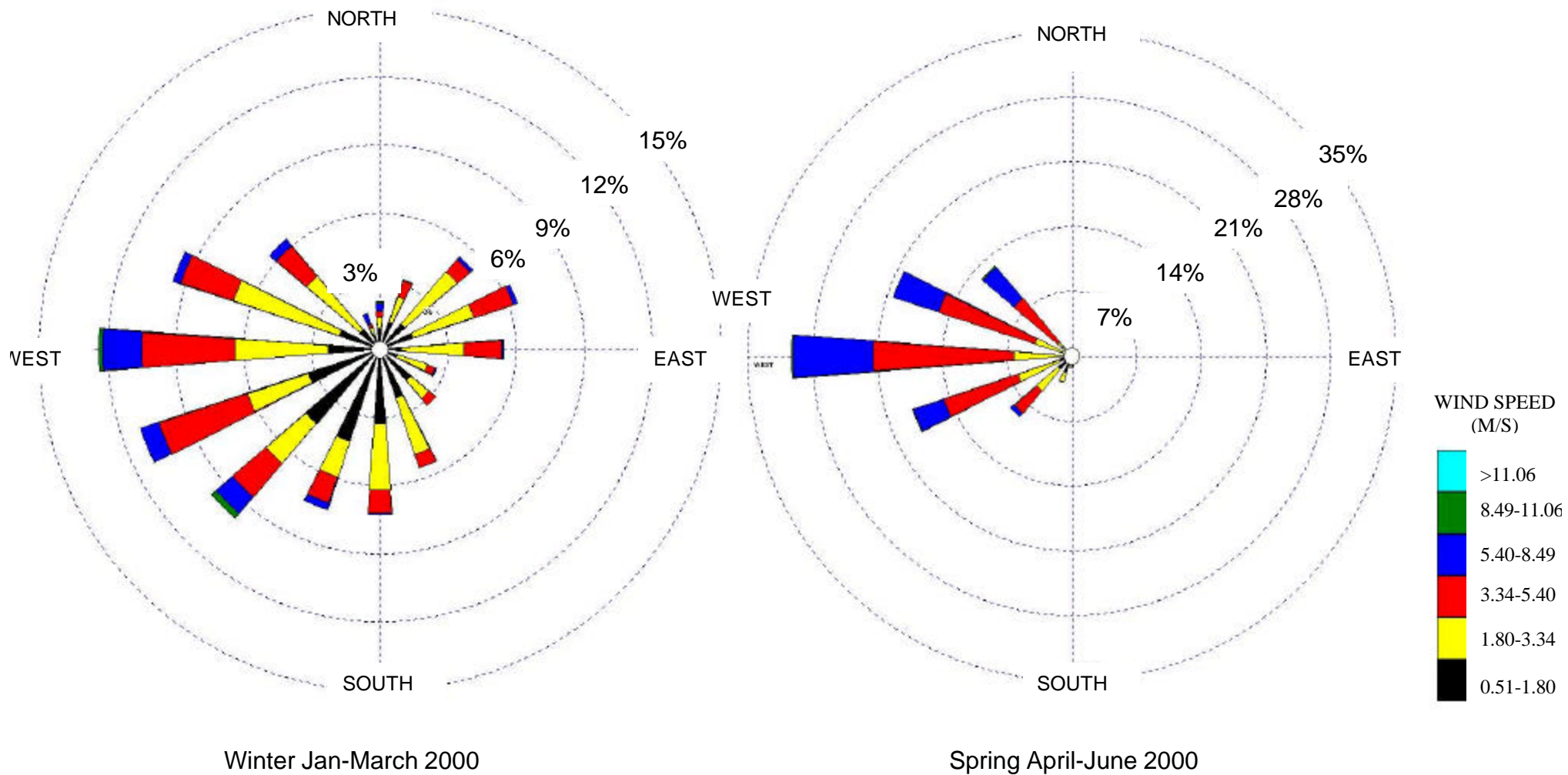
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-2: Seasonal Wind Roses at Tesoro (Martinez) Oil Refinery (cont.)



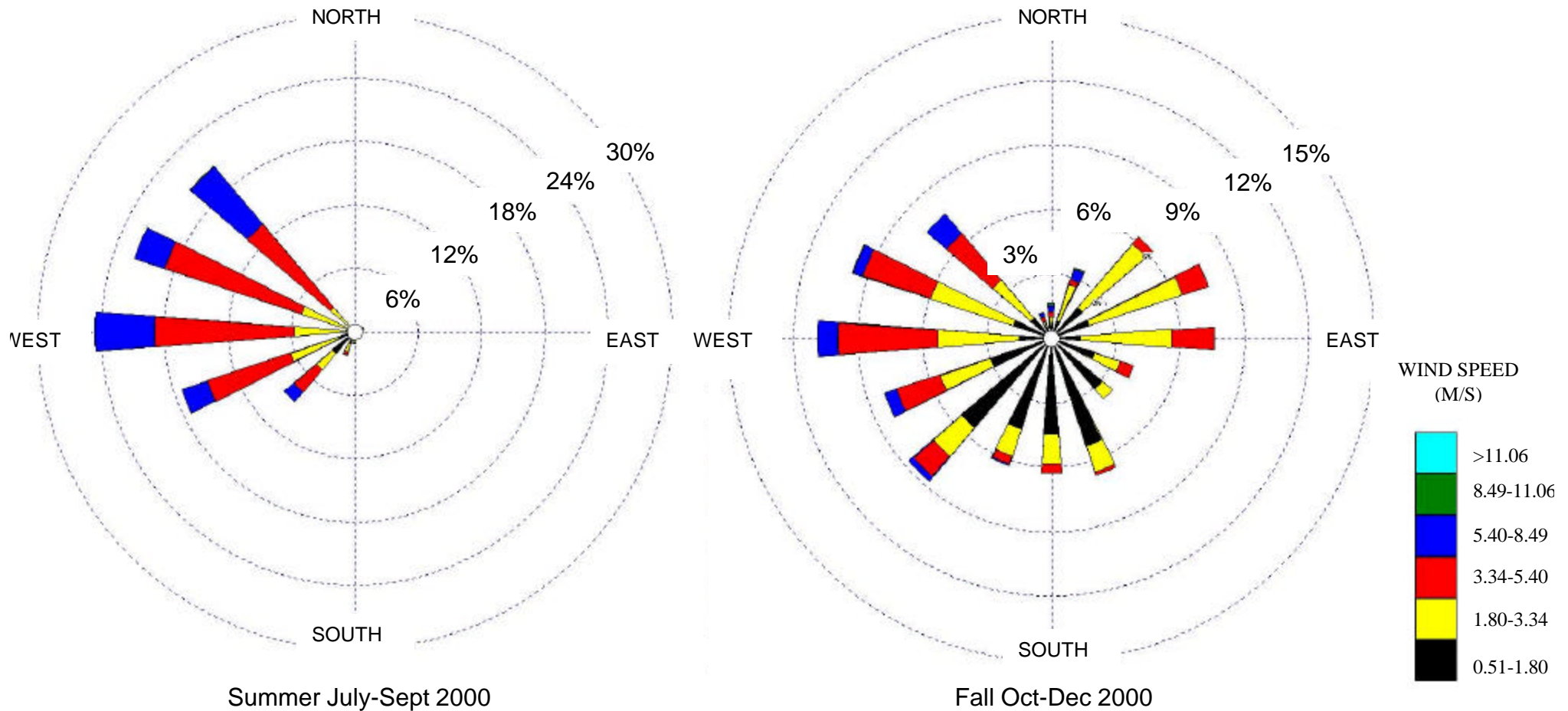
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-3: Seasonal Wind Roses at Shell Refinery Products (Martinez) Oil Refinery



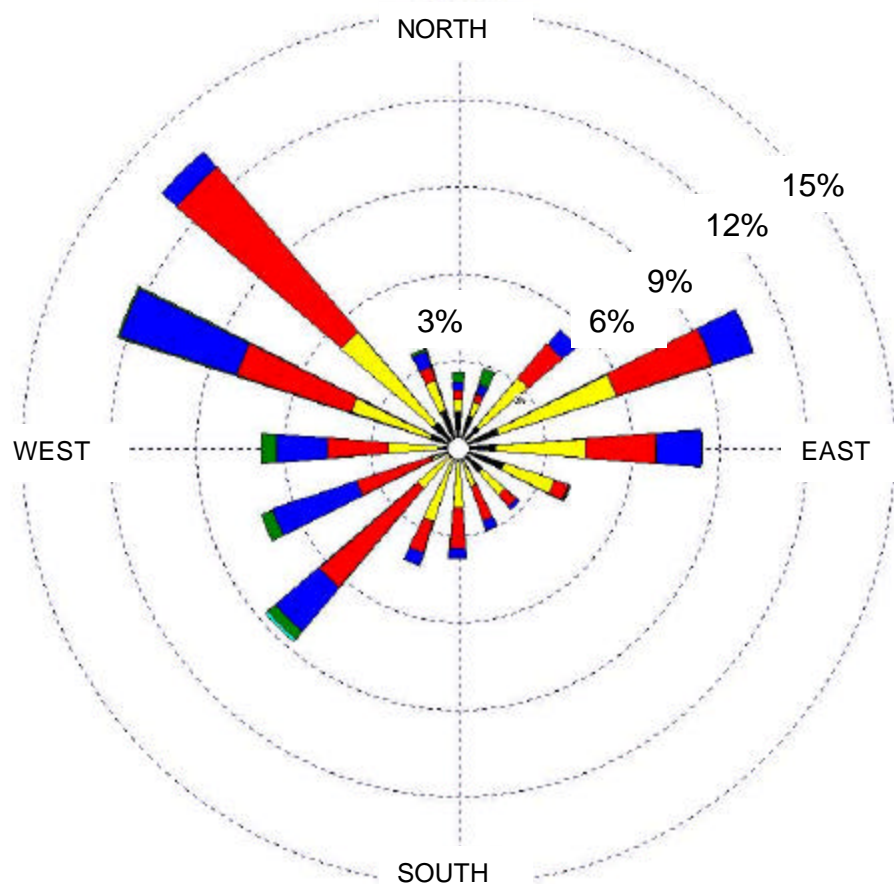
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-3: Seasonal Wind Roses at Shell Refinery Products (Martinez) Oil Refinery (cont.)

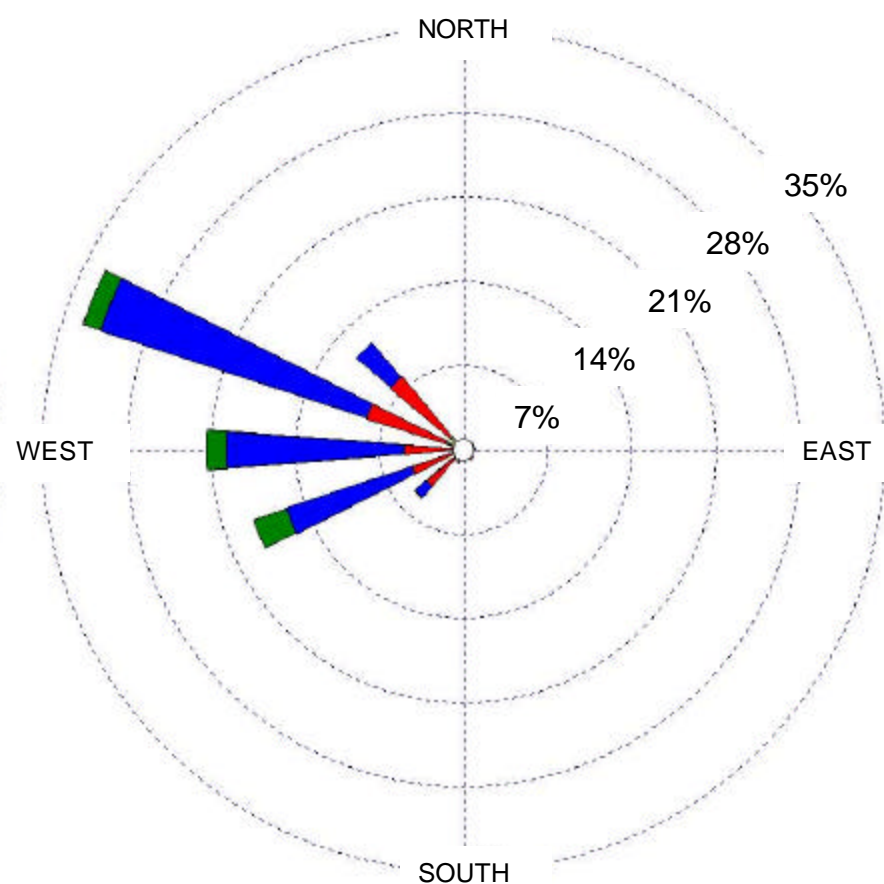


Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-4: Seasonal Wind Roses at Valero (Benicia) Oil Refinery

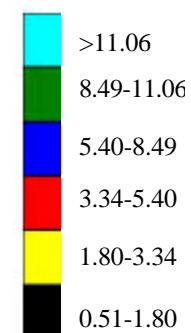


Winter Jan-March 2000



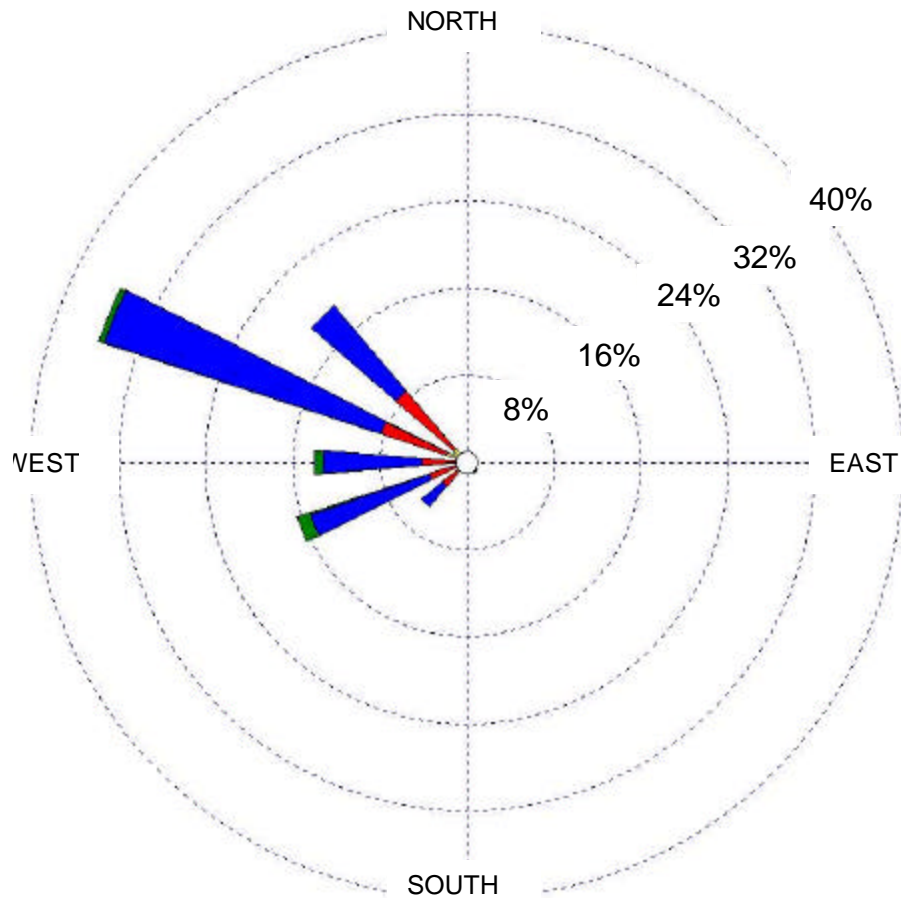
Spring April-June 2000

WIND SPEED
(M/S)

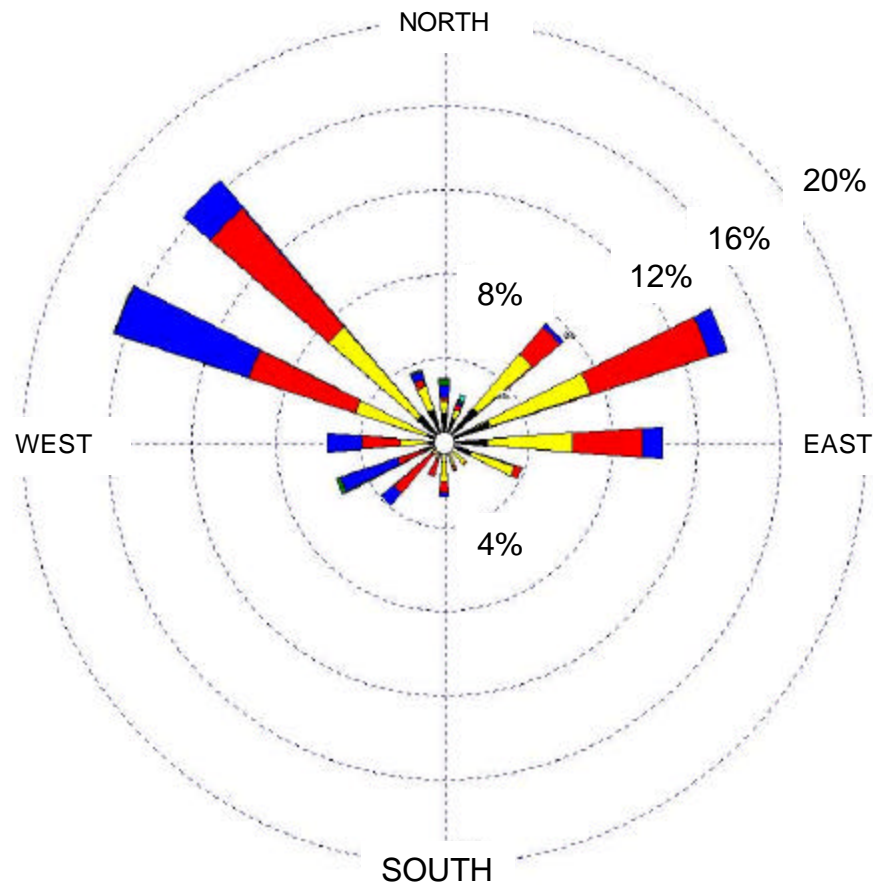


Note: Wedges on charts indicate direction the wind is blowing from.

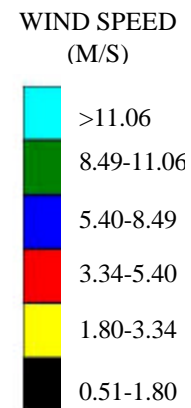
Attachment B-4: Seasonal Wind Roses at Valero (Benicia) Oil Refinery (cont.)



Summer July-Sept 2000

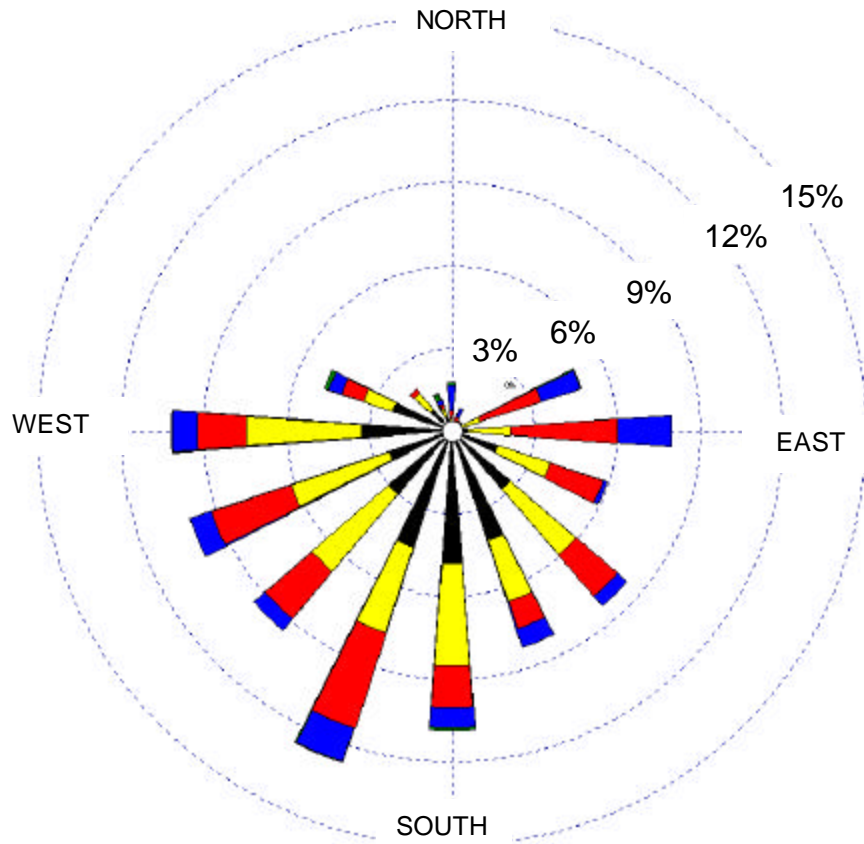


Fall Oct-Dec 2000

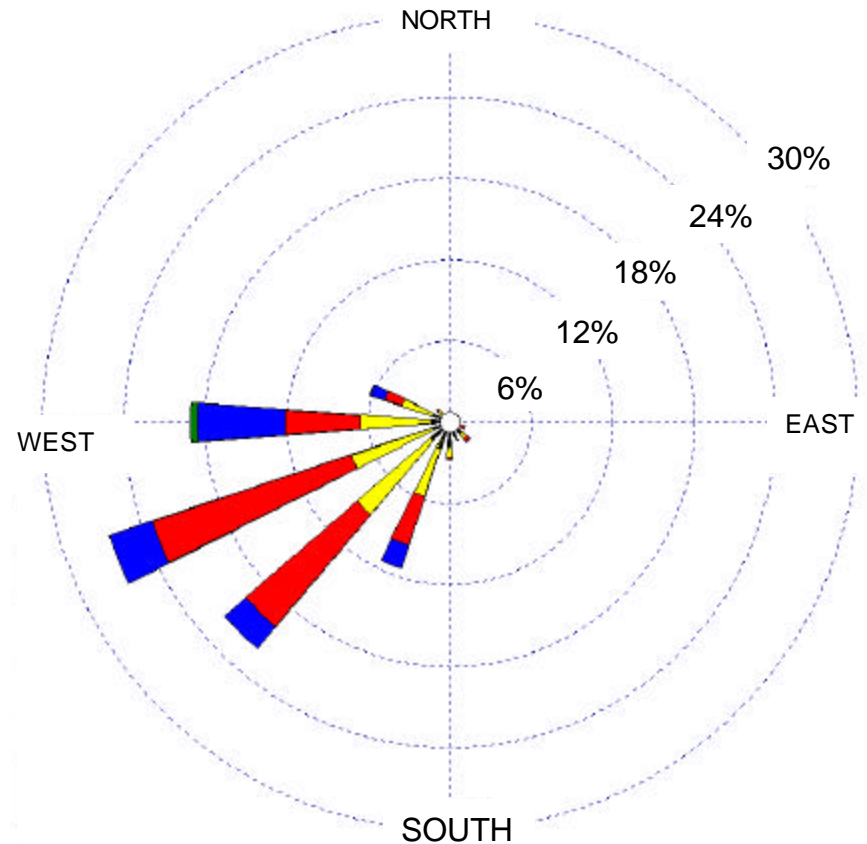


Note: Wedges on charts indicate direction the wind is blowing from.

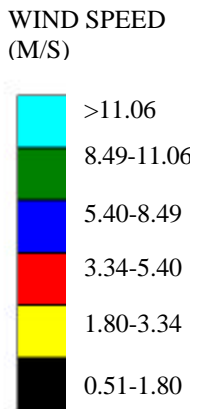
Attachment B-5: Seasonal Wind Roses at Phillips 66 (Rodeo) Oil Refinery



Winter Jan-March 2000

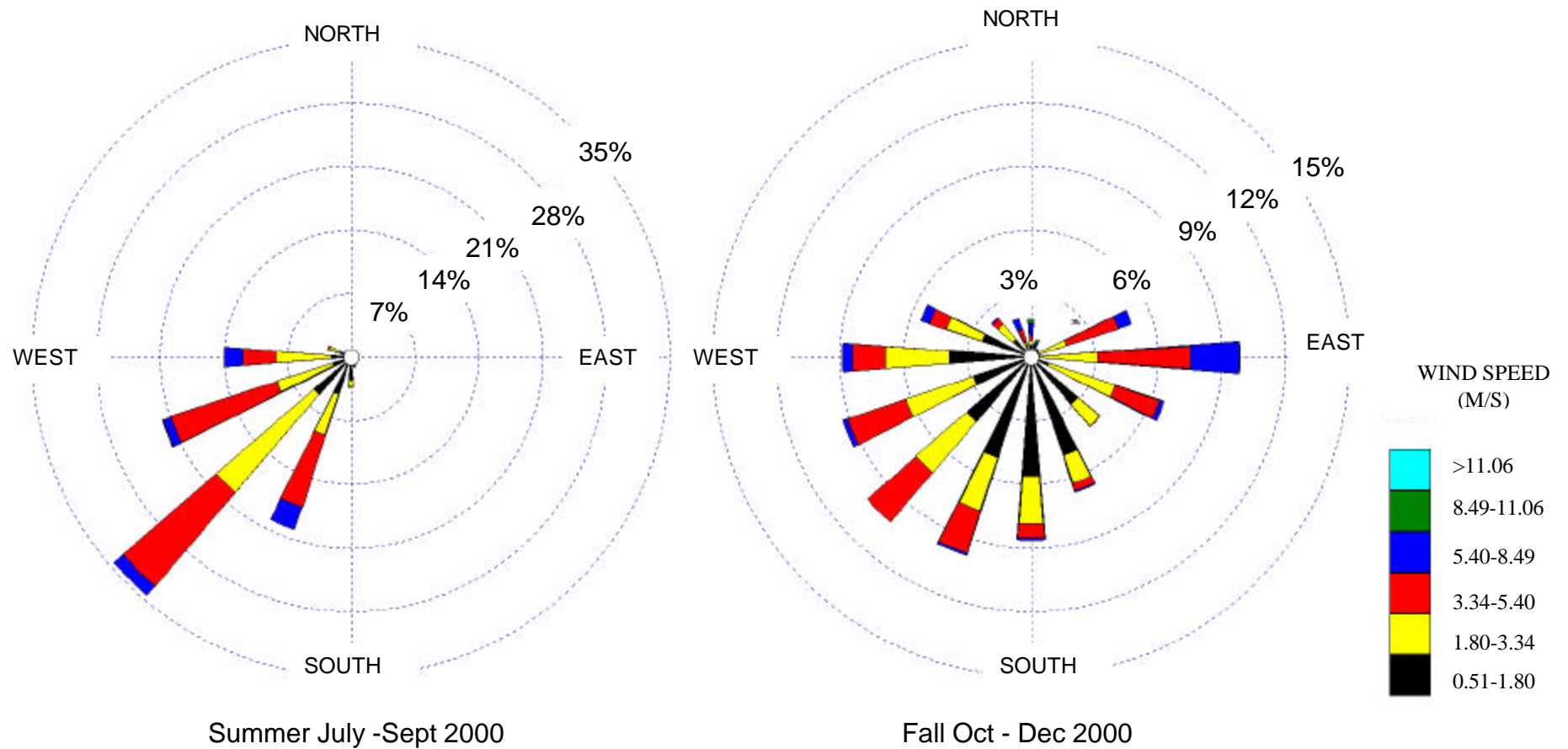


Spring April-June 2000



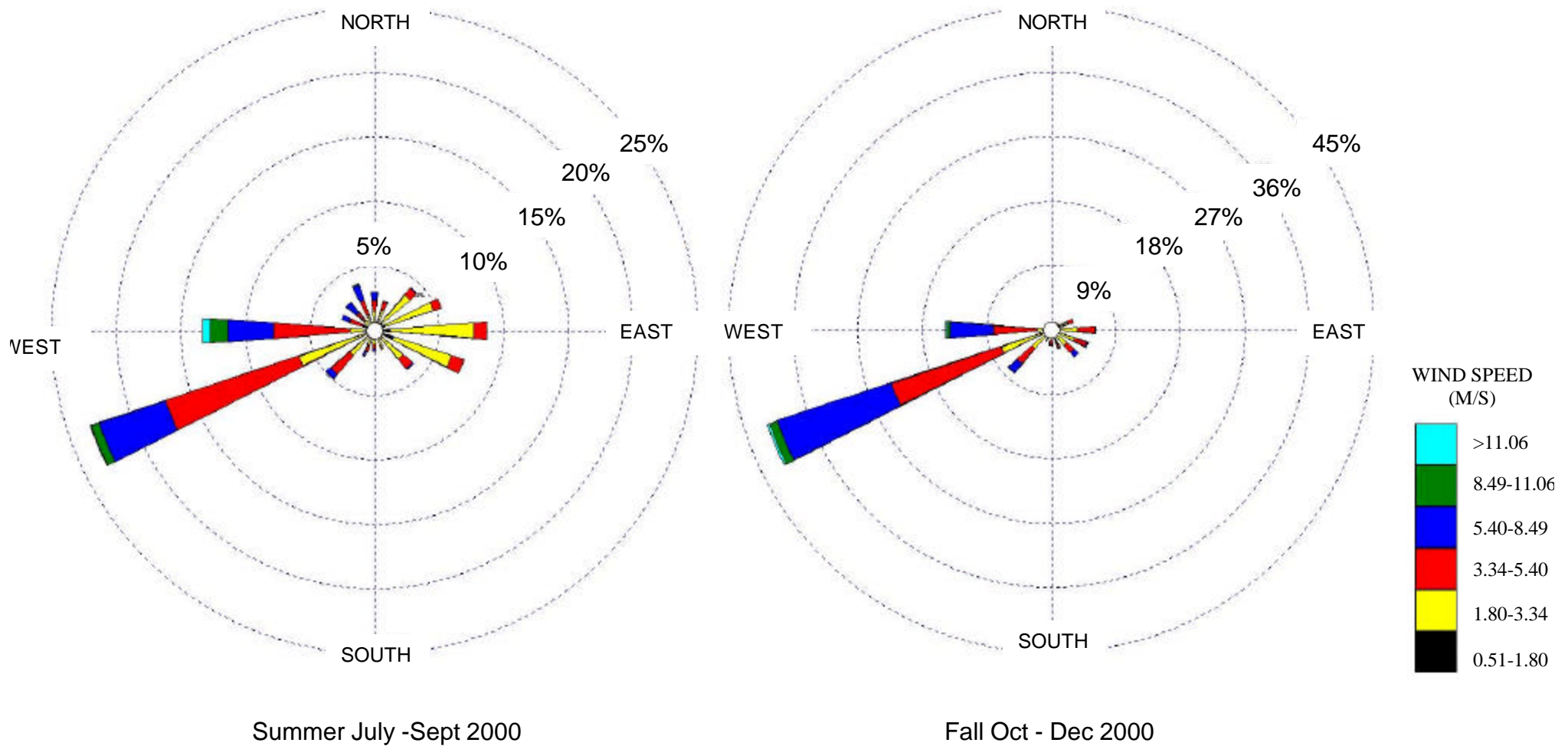
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-5: Seasonal Wind Roses at Phillips 66 (Rodeo) Oil Refinery (cont.)



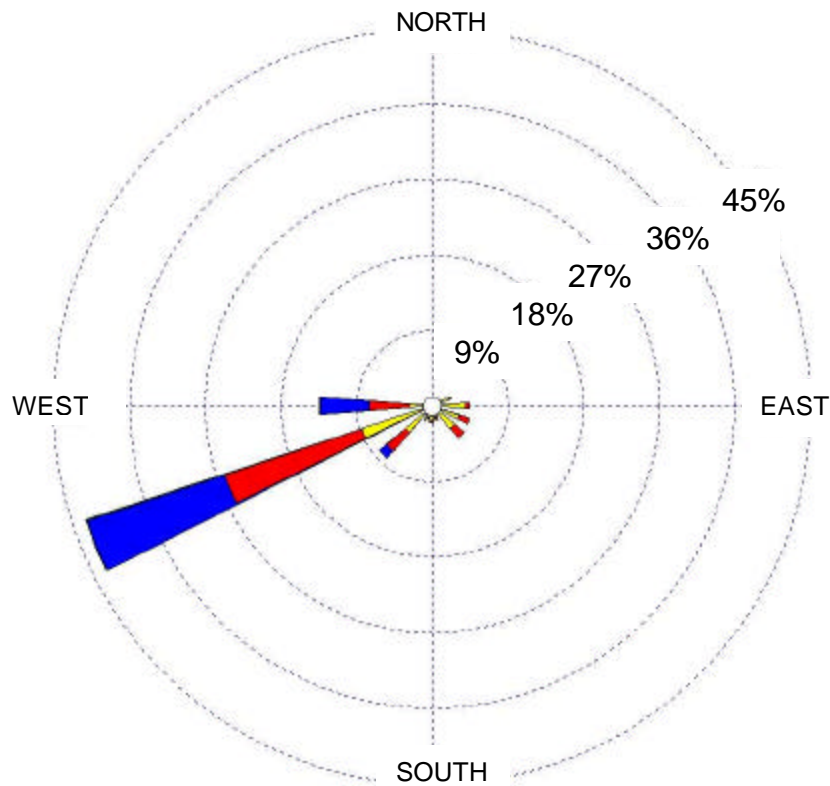
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-6: Seasonal Wind Roses at Los Angeles International Airport

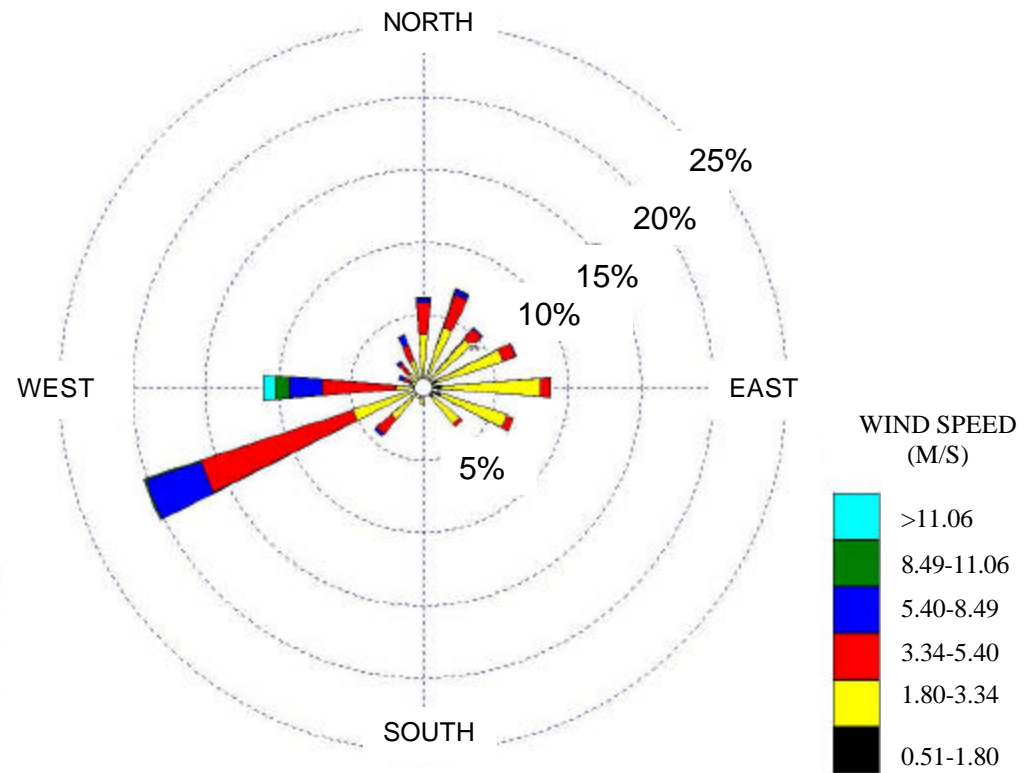


Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-6: Seasonal Wind Roses at Los Angeles International Airport (cont.)



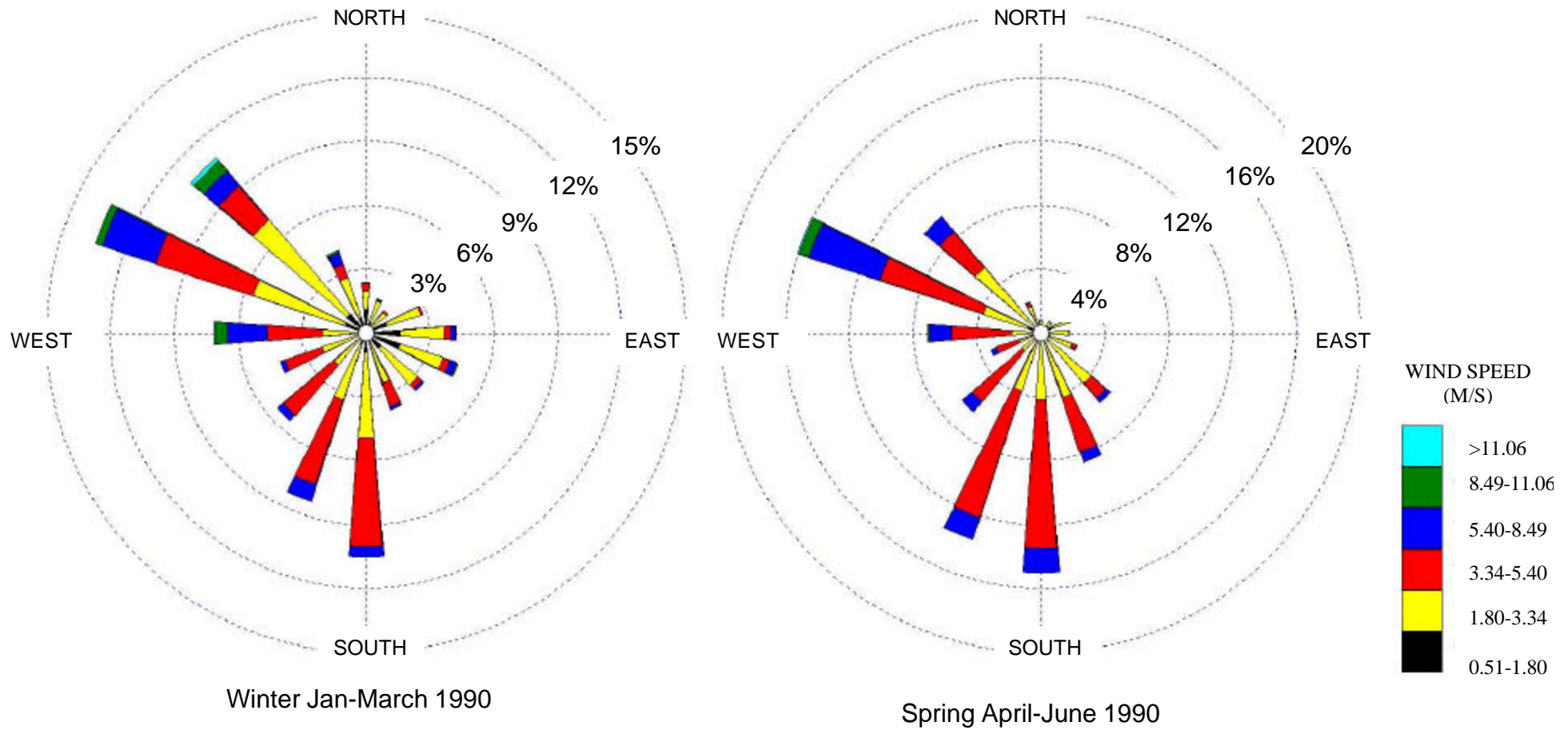
Summer July-Sept 1990



Fall Oct-Dec 1990

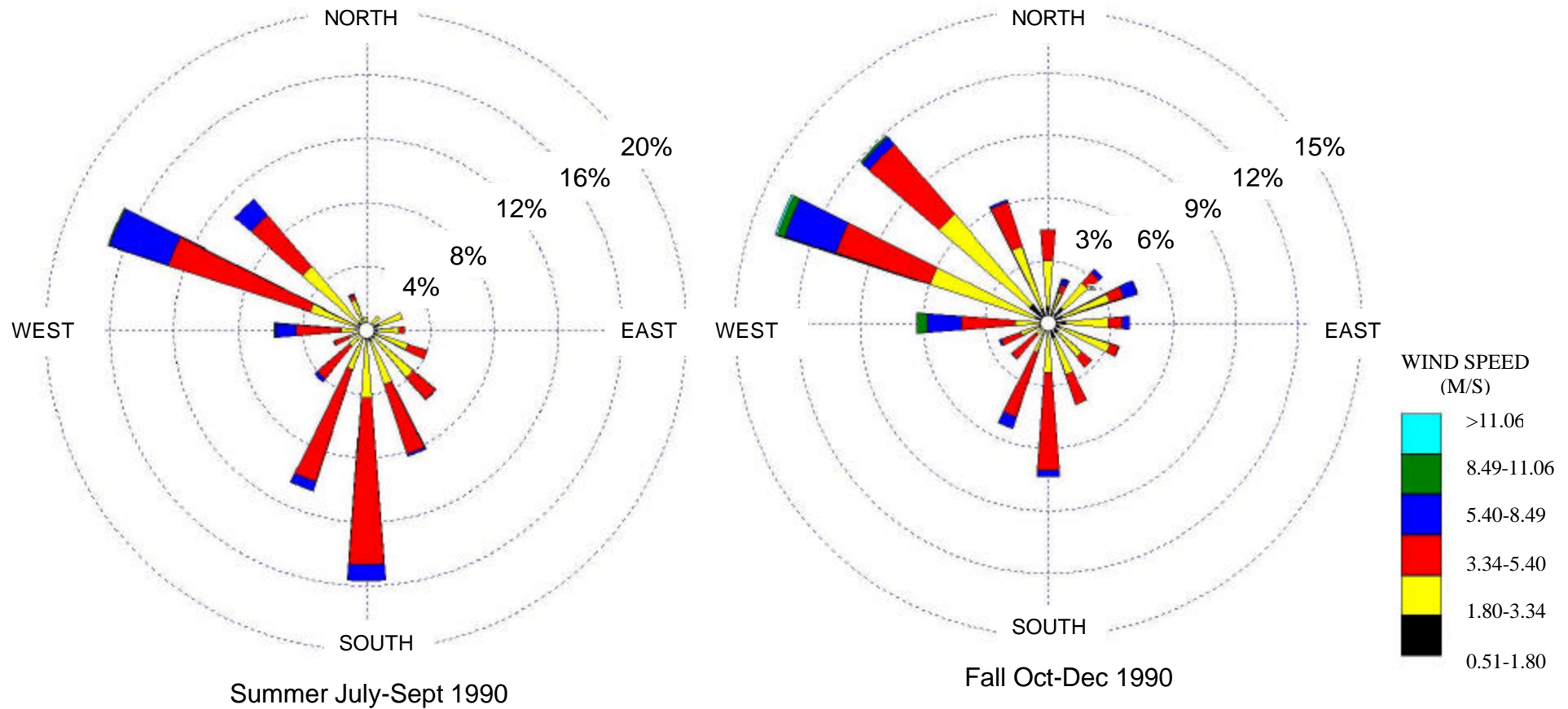
Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-7: Seasonal Wind Roses at Long Beach Daugherty Field



Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-7: Seasonal Wind Roses at Long Beach Daugherty Field (cont.)



Note: Wedges on charts indicate direction the wind is blowing from.

Attachment B-8: Air Monitoring Stations in the San Francisco Bay Area near Chevron (Richmond)



Note: Stations indicated on map are operated and/or required by the district.

Attachment B-9: Air Monitoring Stations in the San Francisco Bay Area near Tesoro (Martinez)



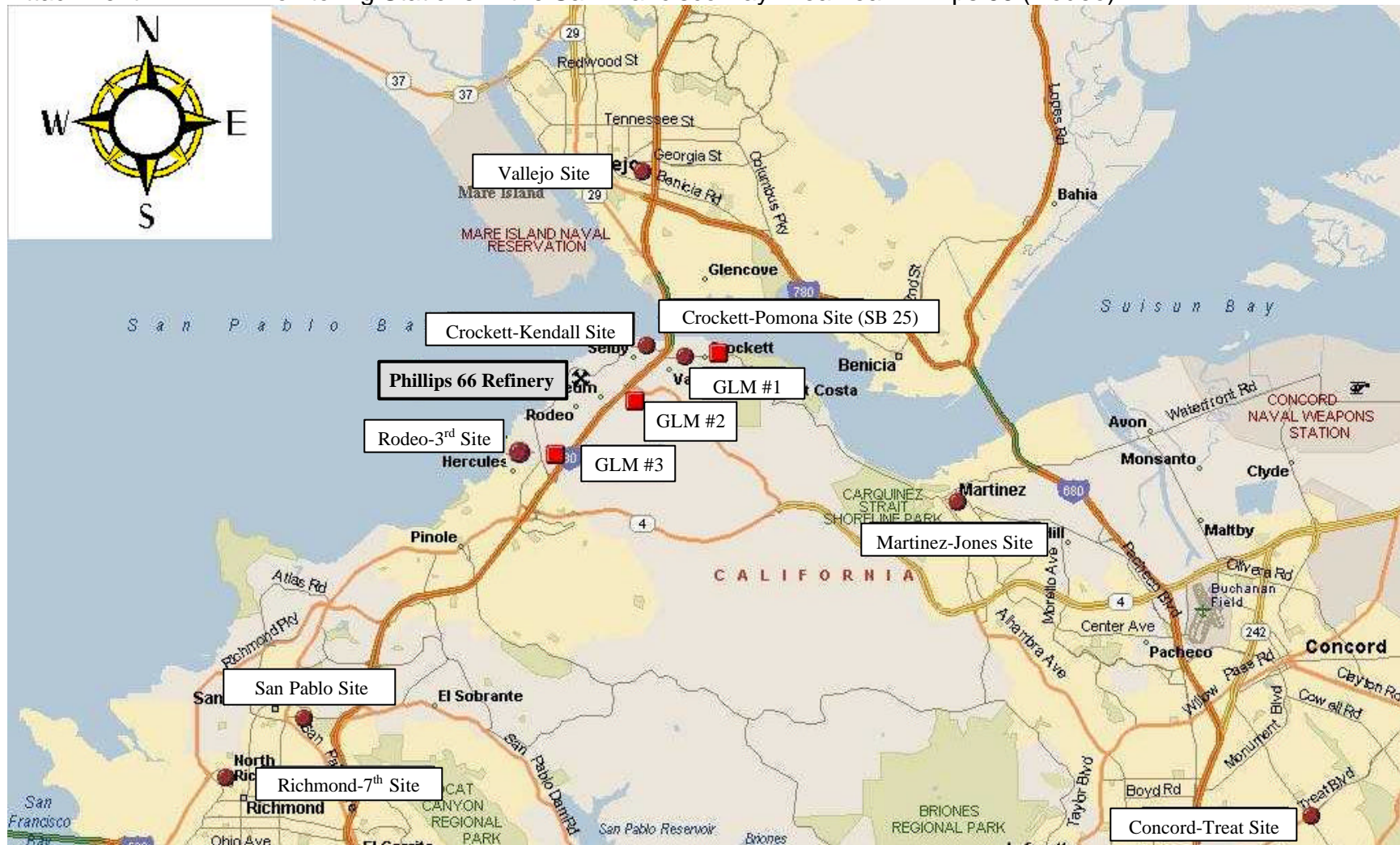
Note: Stations indicated on map are operated and/or required by the district.

Attachment B-11: Air Monitoring Stations in the San Francisco Bay Area near Valero (Benicia)



Note: Stations indicated on map are operated and/or required by the district.

Attachment B-12: Air Monitoring Stations in the San Francisco Bay Area near Phillips 66 (Rodeo)



Note: Stations indicated on map are operated and/or required by the district.

Attachment B-13: Air Monitoring Stations in the South Coast near Oil Refineries



Note: Stations indicated on map are operated and/or required by the district.